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The effects of clear-felling established forestry on streamflow losses from the Hore sub-catchment

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Abstract

The effects on streamflow of clear-felling a substantial part of the established forestry within the Hore sub-catchment at Plynlimon were estimated by a regression comparison of pre-and post-felling rainfall/runoff relationships and by a model based on evapotranspiration estimates from plot studies of established forestry and heather moorland. Increases in streamflow were predicted using both methods, with those using the regression method being substantially larger than those using the model. The largest increases using the regression method occurred about 5 years after the end of felling, and amounted to 10.5% of the measured annual flow.

On a seasonal basis, the largest increases using the regression method occurred during the latter half of the year, whilst the model predicted the largest increases during the summer months. These patterns are explained in terms of forest transpiration and canopy interception.

Introduction

Many of the forested areas in the Hafren forest at Plynlimon are well within the felling age, typically 40–60 years, for coniferous forestry in upland areas of the UK. In 1985, the Forestry Commission initiated a programme of felling within the Hafren. Most of this took place in the Hore sub-catchment, and involved the felling of Norway and Sitka spruce planted in 1937/38 and 1948 to 1950.

Past studies reported in the literature have described detrimental effects on streamflow from clear-felled catchments. These include increases in streamflow (Bosch and Hewlett, 1982), nutrient losses (Likens *et al.*, 1970) and sediment losses (Packer, 1965). Such effects, should they occur in the Plynlimon area, are of particular concern, as runoff from the Hafren, and other forested areas, drains directly into Llyn Clywedog, a river regulation reservoir.

This paper describes a study of the effects of the clear-felling on streamflow from the Hore. It complements past studies on nutrient (Durand *et al.*, 1994) and sediment losses (Leeks, 1992).

Study area

A detailed description of the land use, soils, and geology of the Severn catchment has been given in Newson (1976), and the hydrological instrumentation and results up to 1985, immediately prior to the felling, are given in Kirby *et al.*, 1991. Long term (1975–1984) average annual rainfall to the Hore is 2514 mm; of this, 1850 mm became streamflow.

The felling in the Hore began in the summer of 1985 and continued for approximately four years. The timing and extent of the felling was determined by digitizing a map of the felling schedule supplied by the Forestry Commission (Fig. 1). This produced the timetable shown in Table 1.

This timetable shows that, during the four year felling period, an area of 90.8 ha, or 28.9% of the catchment area, was affected. This figure was confirmed by the analysis of two Landsat images of the area, one recorded on the 27th September 1985, and the other on the 6th September 1989. This analysis showed that 88.2 ha has been felled within the Hore (Roberts *et al.*, 1994).

The Forestry Commission Schedule (Fig. 1 and Table 1) shows that some felling occurred prior to 1985. This occurred mainly in 1981 and 1982 and involved unproductive areas affected by windthrow in the upper reaches of the sub-catchment. It would be expected that the felling of these unproductive areas would have a minimal effect on streamflow compared with the felling of the larger, more productive forestry areas in the lower reaches of the sub-catchment. Most of the felling in these areas occurred in 1985 and 1986 (Table 1). Whole-tree harvesting was not employed, and a great deal of brash was left on the ground